

Benthic Macroinvertebrate Monitoring Data

Data Sources

Data were obtained from three sources: OREIS, Lockwood Green Technologies, and hand entry from the ED-1 MAP reports. OREIS data were received as a tab-delimited ASCII file queried from the OREIS database. The OREIS data included the population surveys of benthic macroinvertebrates at EFK 6.3 from 1985 through 1999 and at BCK3.3 from 1984 through 2001. Lockwood Green data were received as Excel spreadsheets. These data included benthic macroinvertebrate surveys from 1998 to 2000. Data were hand entered into Excel spreadsheets from the 1997 MAP reports.

Data Processing

SAS data analysis software was used to summarize and graph the data. The total number of benthic organisms was summed across each location, year, season and sampler. From 3 to 5 surber samplers were used at each location and sampling event. From the sum per sampler, the average number of organisms and taxa per sample were computed (Table 1). The taxa included in the Ephemeroptera, Tricoptera, and Plecoptera (EPT) orders of insects were identified. The total number of organisms in these three orders was summed for each sample and the average was used to calculate the percent EPT organisms for each location and sampling event (Table 1). The percent of chironomid organisms was calculated in a similar manner (Table 1). These data for each location, season, were plotted by year to allow for a visual examination of temporal trends in the data (Figures 1 to 12).

Summary statistics were calculated for the average number of organisms per sample and the average number of taxa per sample for each season and location (Tables 2 and 3). The summary statistics include the total number of samples, mean, standard deviation, coefficient of variation, maximum, minimum, and the probability for normality test. The coefficient of variation (CV) is the standard deviation divided by the mean and taken as a percent. The CV is a measure of the variability of the measurement. The probability for normality test is the probability for the Shapiro-Wilk test for determining if the data are different from a normal distribution. Data with probability values less than 0.05 would be considered significantly different from normal.

A simple linear regression analysis was performed for the average number of benthic organisms versus year and the average number of taxa versus year to look for a simple linear increase or decrease in the ecological measurements over time. The regression tables contain the parameter estimates for the slope, standard error, probability, R-square, and 95% lower (LCL) and upper (UCL) confidence limits on the slope. Probability values less than the alpha level chosen indicate a statistically significant slope and, therefore, a statistically significant trend. The R-square value indicates how well the linear regression fits the measurements. R-square values close to 1.0 indicate a very good fit. R-square values close to zero indicate a poor fit (Tables 4 and 5).

Plots (Figures 9 to 12), summary statistics (Tables 6 and 7), and regression analyses (Tables 8 and 9) were also computed for the percent EPT and percent chironomid data.

References

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Proprietary Software Release 8.2 (TS2M0)

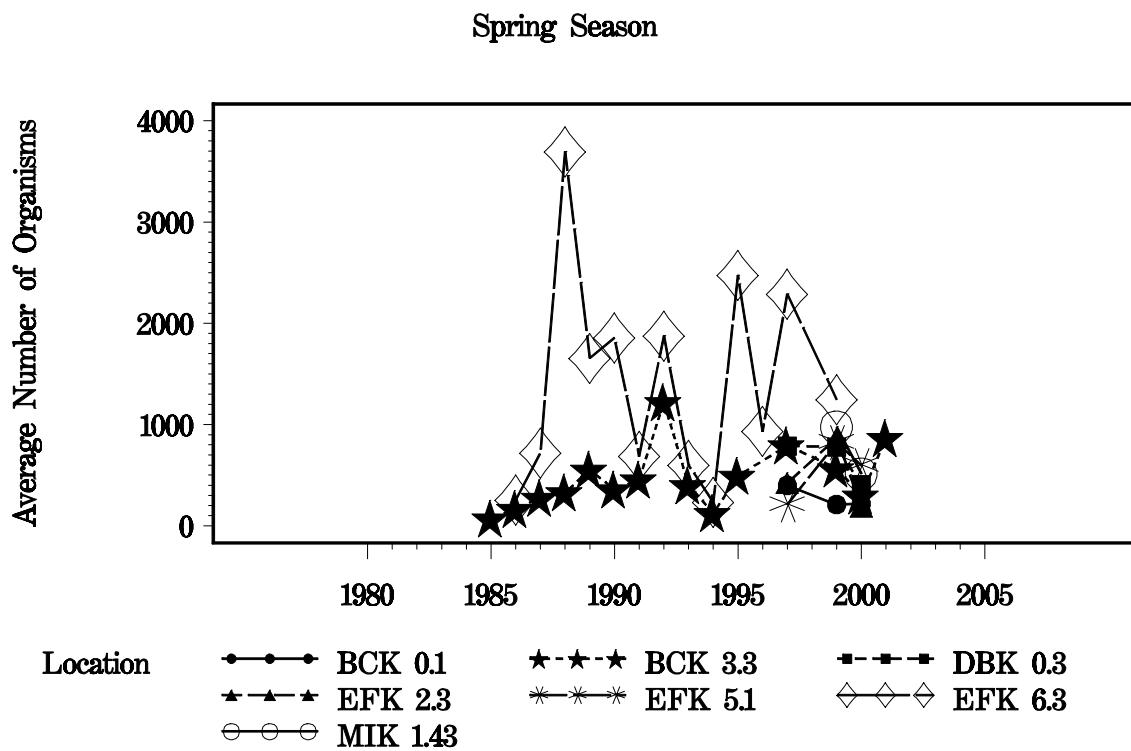


Figure 1. Average number of benthic organisms per sample for the Spring sampling events 1985-2001.

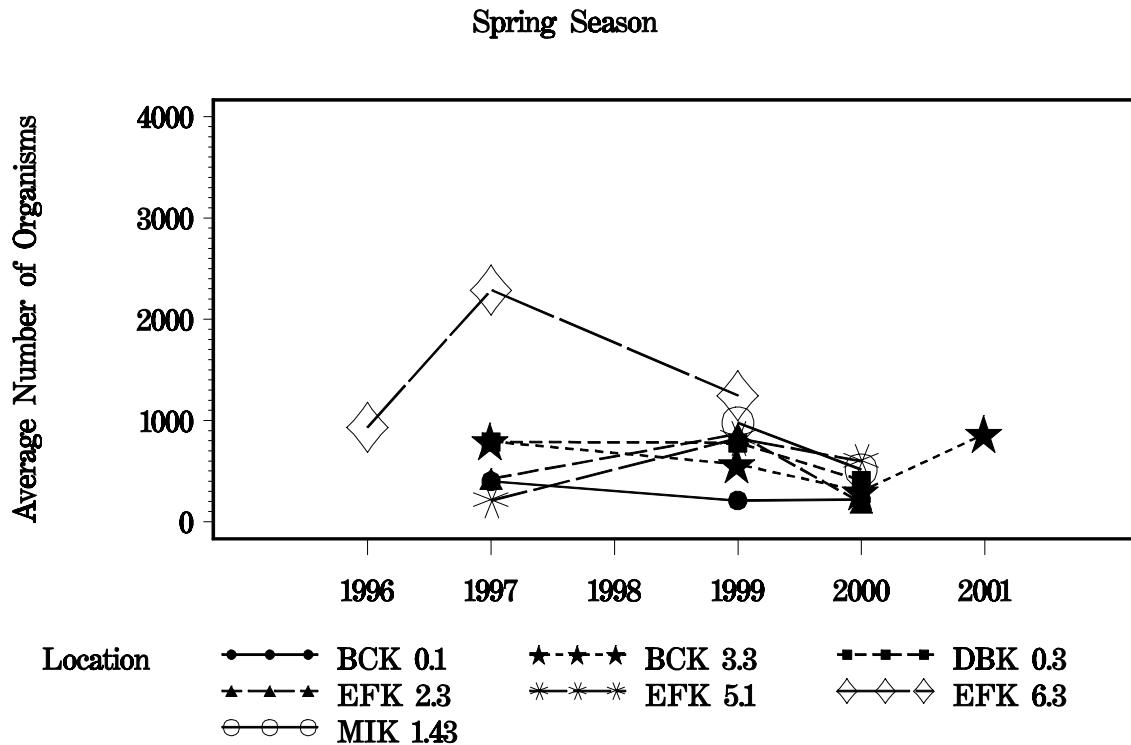


Figure 2. Average number of benthic organisms per sample for the Spring sampling events 1996-2001.

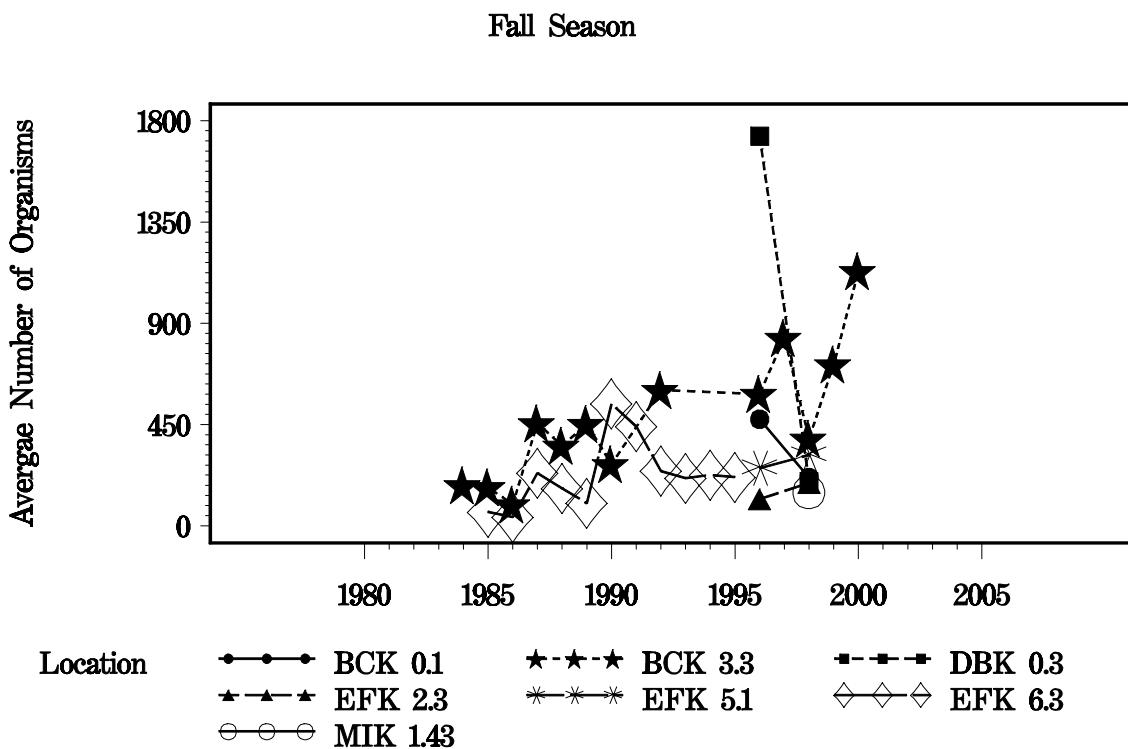


Figure 3. Average number of benthic organisms per sample for the Fall sampling events 1984-2000.

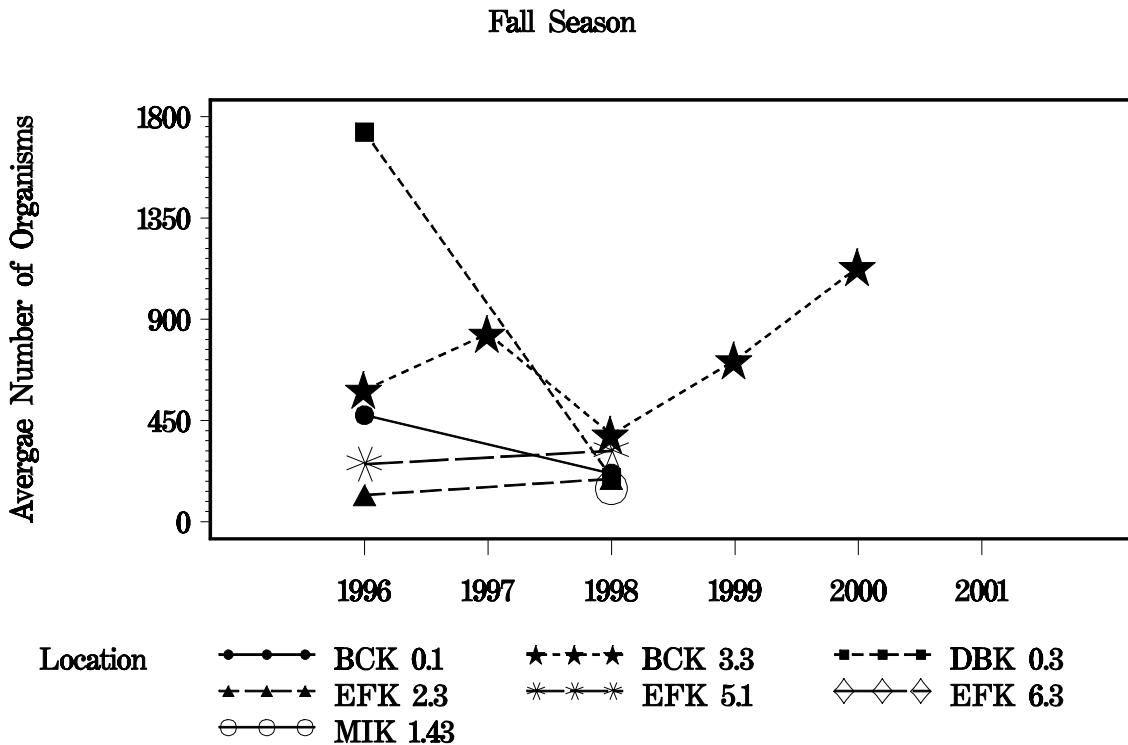


Figure 3. Average number of benthic organisms per sample for the Fall sampling events 1996-2000.

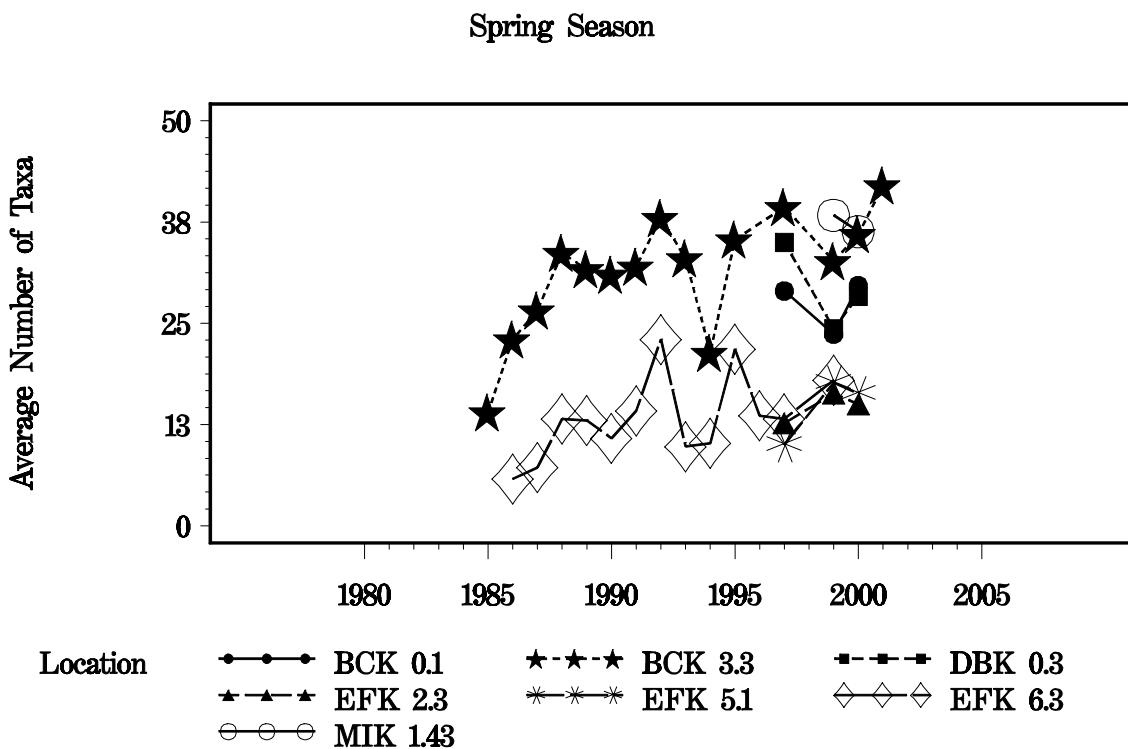


Figure 5. Average number of benthic taxa per sample for the Spring sampling events 1985-2001.

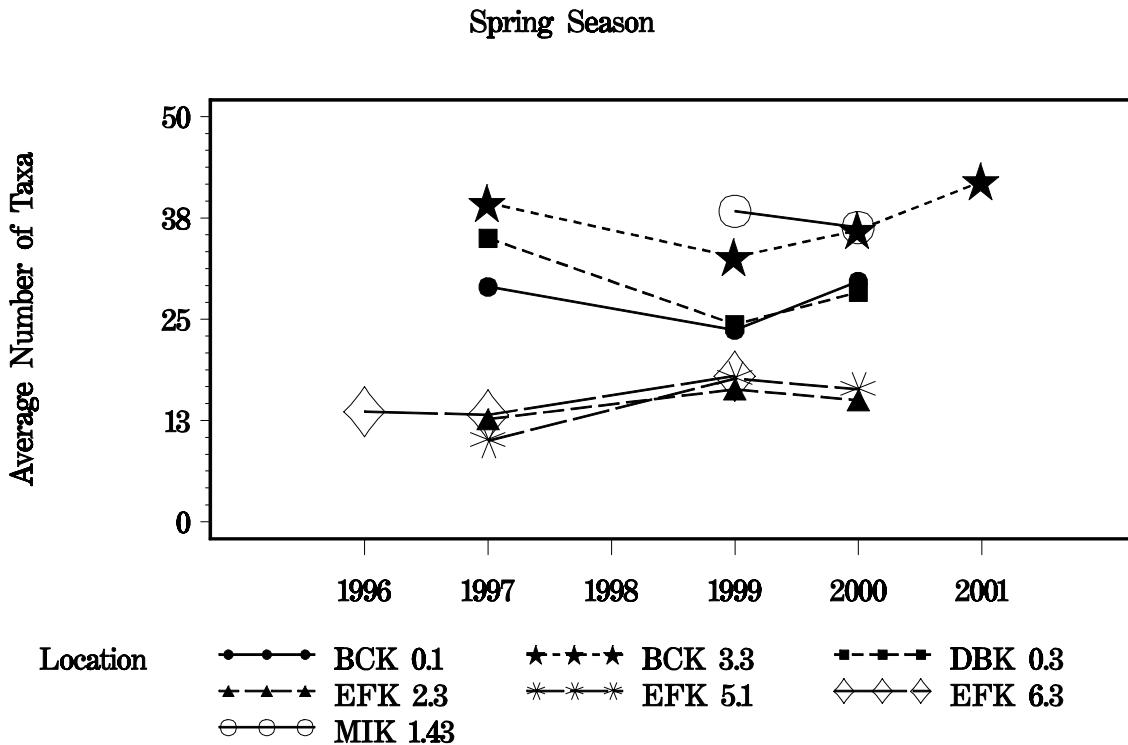


Figure 6. Average number of benthic taxa per sample for the Spring sampling events 1996-2001.

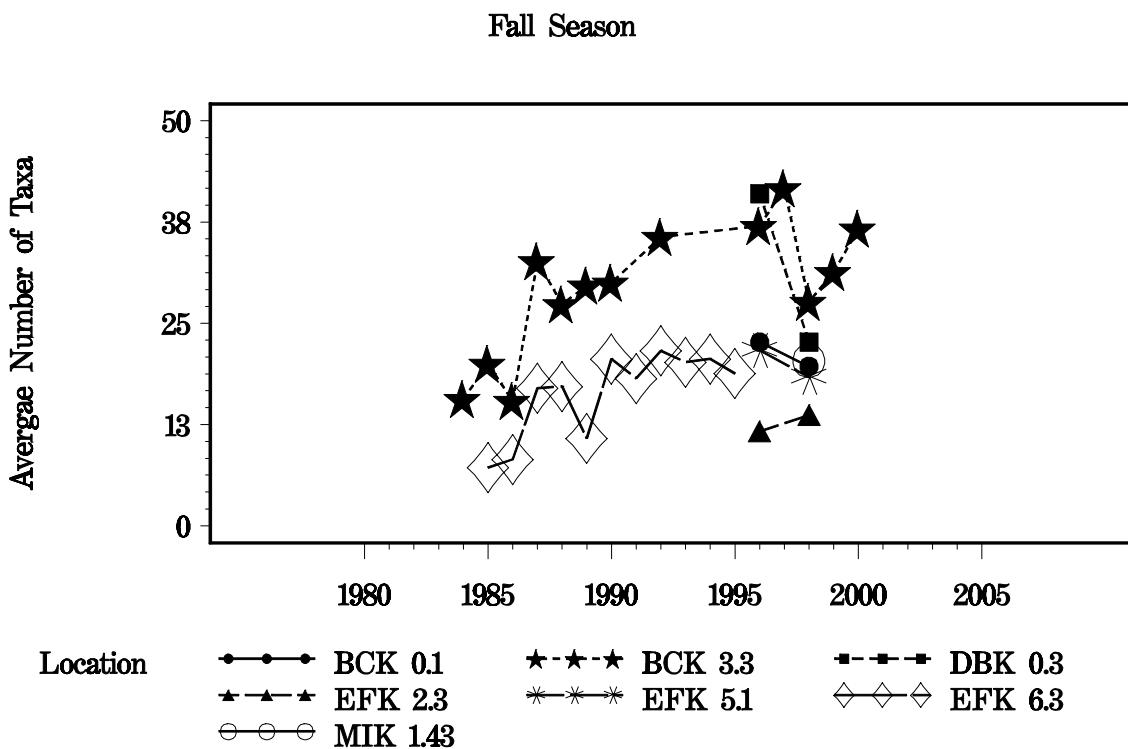


Figure 7. Average number of benthic taxa per sample for the Fall sampling events 1984- 2000.

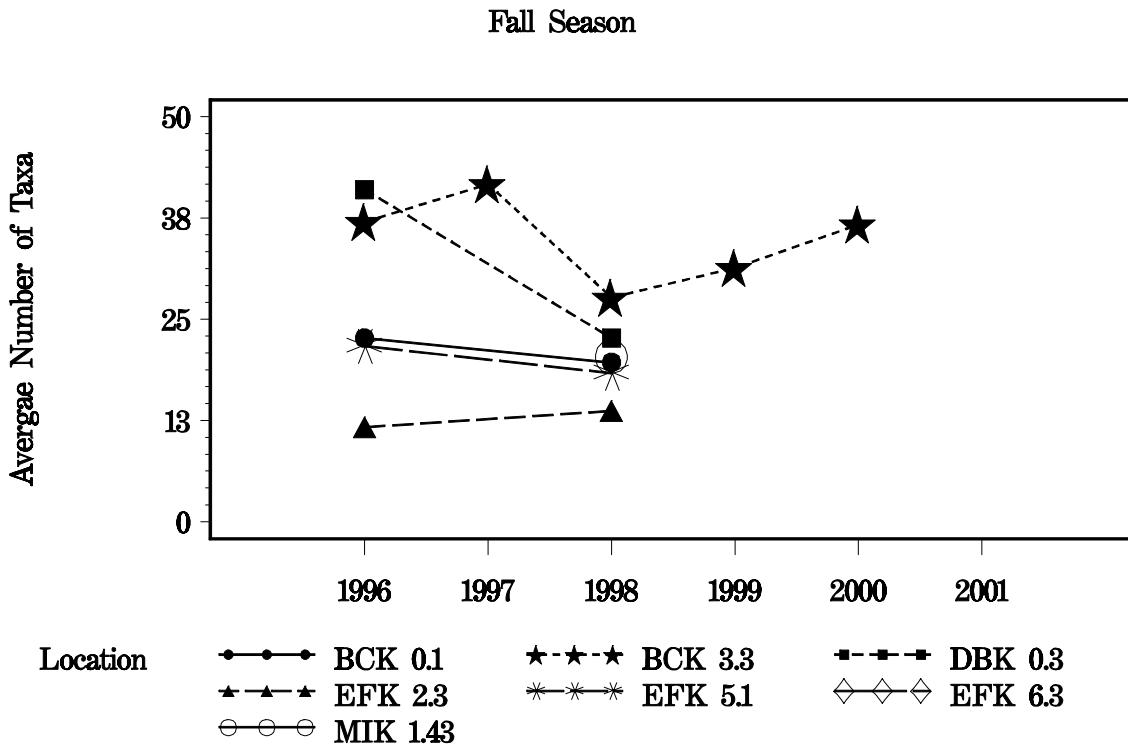


Figure 8. Average number of benthic taxa per sample for the Fall sampling events 1996- 2000.

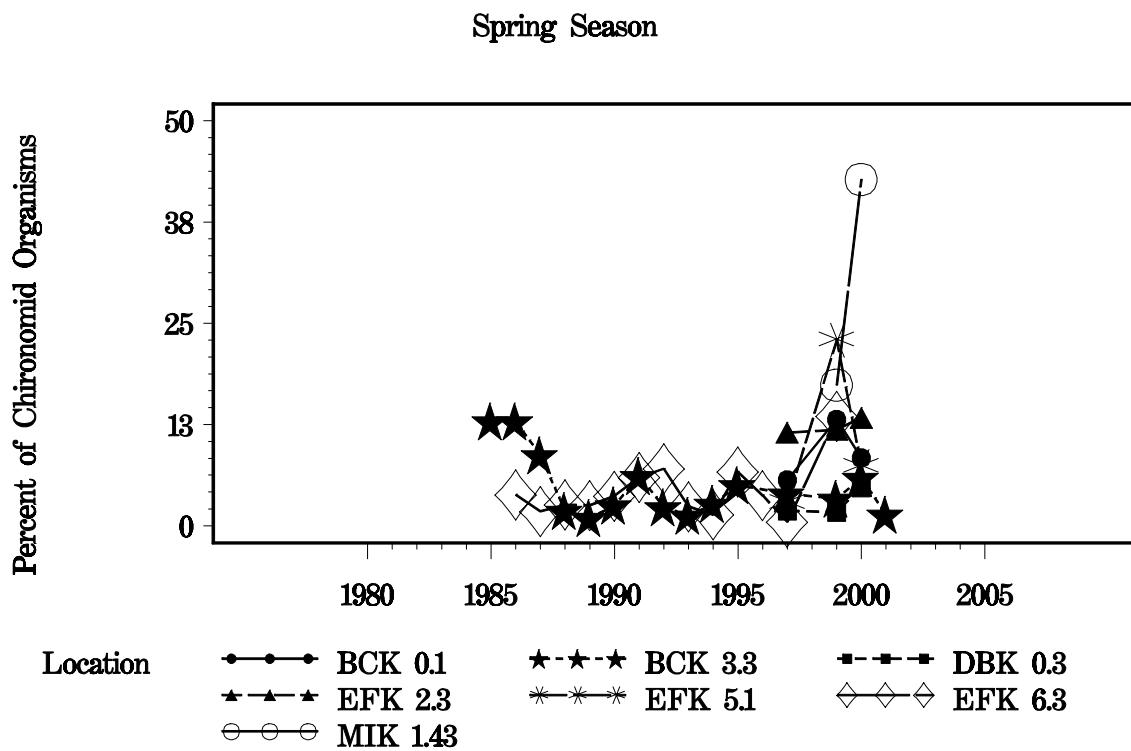


Figure 9. Percent chironomid organisms per sample for the Spring sampling events 1985- 2001.

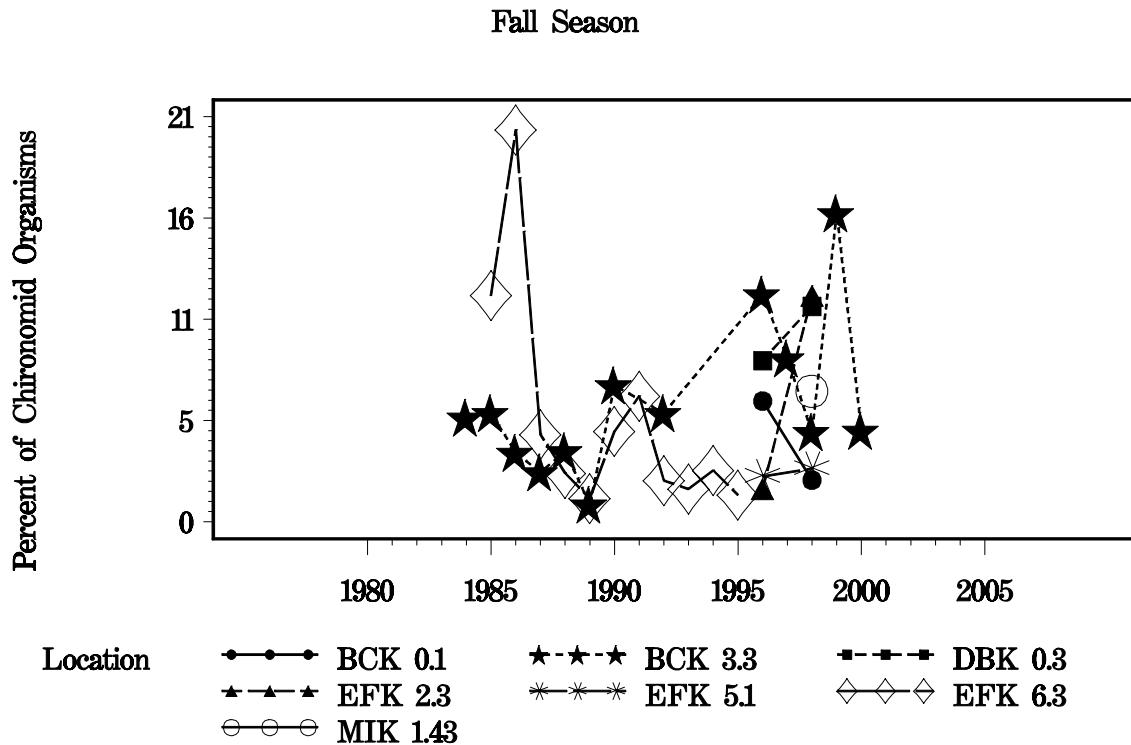


Figure 10. Percent chironomid organisms per sample for the Fall sampling events 1984- 2000.

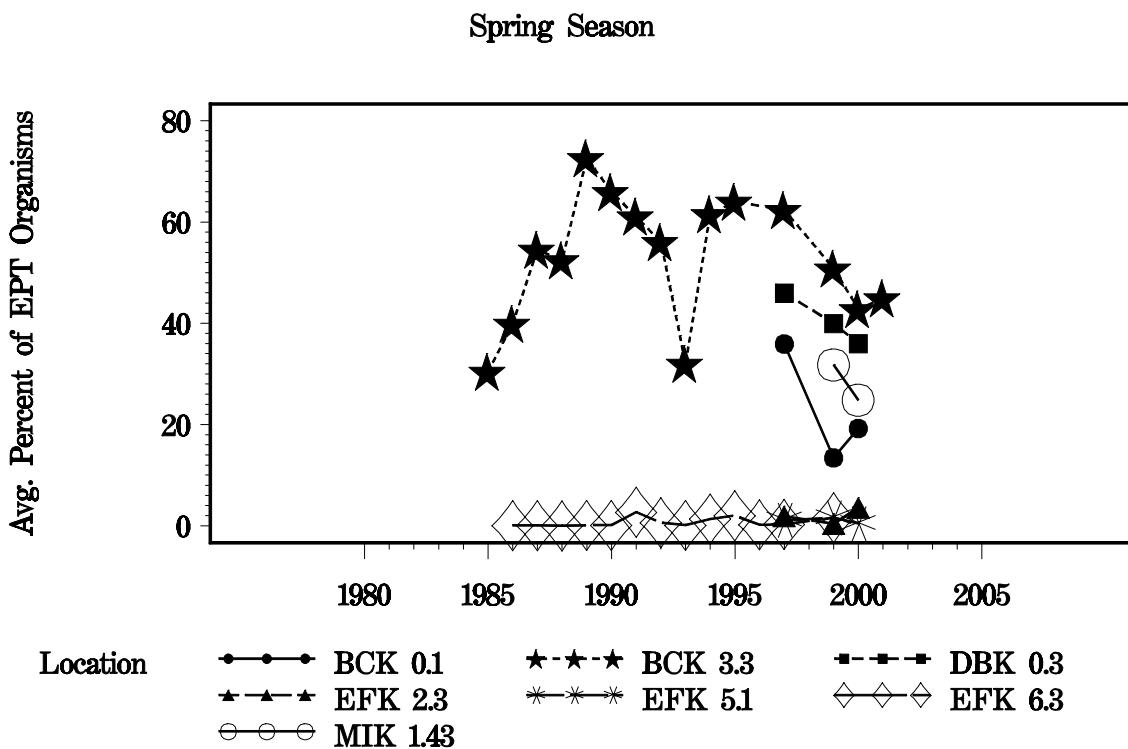


Figure 11. Percent EPT organisms per sample for the Spring sampling events 1985- 2001.

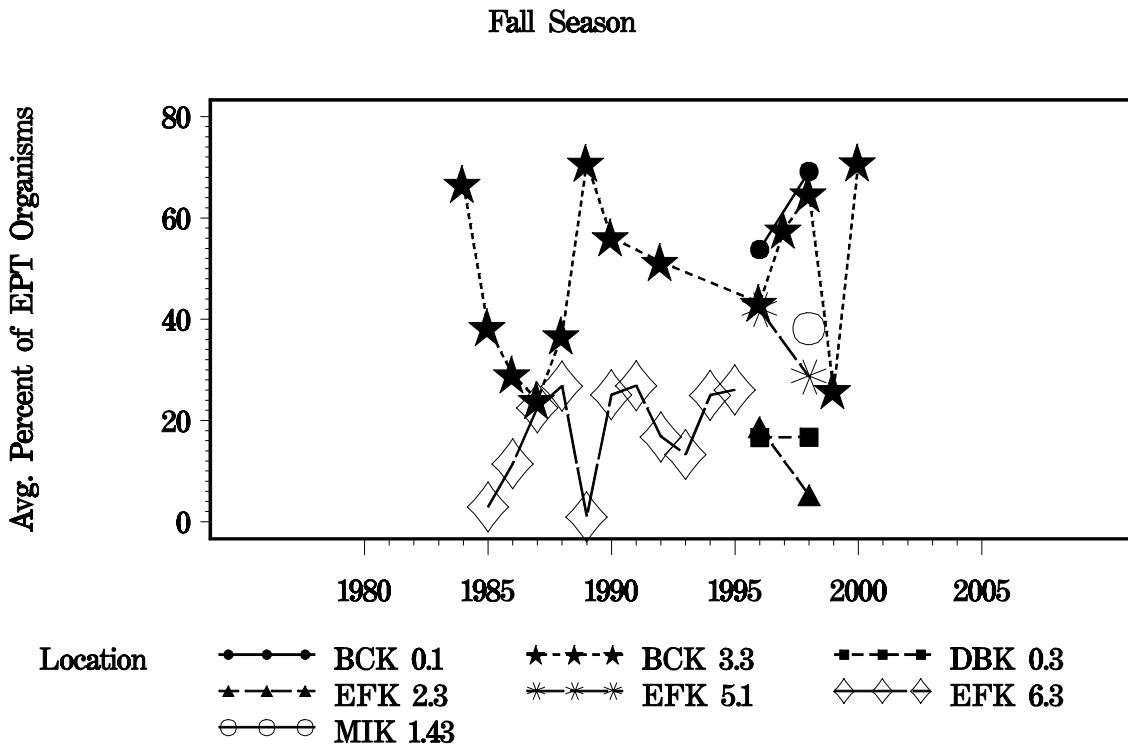


Figure 12. Percent EPT organisms per sample for the Fall sampling events 1984- 2000.

Table 1. ED-1 Benthic Data Summarized by Event

Location	Year	Season	Average Number of Organisms per Sample	Average Number of Taxa per Sample	Average Percent of EPT Organisms	Average Percent of Chironomid Organisms
BCK 0.1	1997	Spring	400	29	36	6
BCK 0.1	1999	Spring	210	24	13	13
BCK 0.1	2000	Spring	222	30	19	8
BCK 0.1	1996	Fall	474	23	54	6
BCK 0.1	1998	Fall	215	20	69	2
BCK 3.3	1985	Spring	72	14	30	13
BCK 3.3	1986	Spring	167	23	40	13
BCK 3.3	1987	Spring	278	27	54	9
BCK 3.3	1988	Spring	329	34	52	2
BCK 3.3	1989	Spring	553	32	73	1
BCK 3.3	1990	Spring	358	31	66	3
BCK 3.3	1991	Spring	456	32	61	6
BCK 3.3	1992	Spring	1221	38	56	2
BCK 3.3	1993	Spring	401	33	32	1
BCK 3.3	1994	Spring	124	21	62	3
BCK 3.3	1995	Spring	493	35	64	5
BCK 3.3	1997	Spring	793	39	62	4
BCK 3.3	1999	Spring	567	33	51	3
BCK 3.3	2000	Spring	300	36	43	6
BCK 3.3	2001	Spring	868	42	45	1
BCK 3.3	1984	Fall	179	16	67	5
BCK 3.3	1985	Fall	171	20	38	6
BCK 3.3	1986	Fall	95	15	29	4
BCK 3.3	1987	Fall	456	33	24	3
BCK 3.3	1988	Fall	355	27	37	4
BCK 3.3	1989	Fall	453	30	71	1
BCK 3.3	1990	Fall	274	30	56	7
BCK 3.3	1992	Fall	604	36	51	6
BCK 3.3	1996	Fall	586	37	43	12
BCK 3.3	1997	Fall	835	42	58	8
BCK 3.3	1998	Fall	388	28	65	5
BCK 3.3	1999	Fall	717	31	26	16
BCK 3.3	2000	Fall	1132	37	71	5
DBK 0.3	1997	Spring	788	35	46	2
DBK 0.3	1999	Spring	781	24	40	2
DBK 0.3	2000	Spring	407	28	36	5
DBK 0.3	1996	Fall	1731	41	17	8
DBK 0.3	1998	Fall	197	23	17	11
EFK 2.3	1997	Spring	423	13	2	11
EFK 2.3	1999	Spring	867	16	0	12
EFK 2.3	2000	Spring	187	15	4	13
EFK 2.3	1996	Fall	118	12	19	2
EFK 2.3	1998	Fall	191	14	5	12
EFK 5.1	1997	Spring	208	10	1	3
EFK 5.1	1999	Spring	824	18	2	23
EFK 5.1	2000	Spring	597	16	0	7
EFK 5.1	1996	Fall	256	22	42	2
EFK 5.1	1998	Fall	315	18	29	3

Table 1. ED-1 Benthic Data Summarized by Event (continued)

Location	Year	Season	Average Number of Organisms per Sample	Average Number of Taxa per Sample	Average Percent of EPT Organisms	Average Percent of Chironomid Organisms
EFK 6.3	1986	Spring	256	6	0	4
EFK 6.3	1987	Spring	720	7	0	2
EFK 6.3	1988	Spring	3694	13	0	3
EFK 6.3	1989	Spring	1655	13	0	3
EFK 6.3	1990	Spring	1857	11	0	4
EFK 6.3	1991	Spring	686	14	3	6
EFK 6.3	1992	Spring	1875	23	1	7
EFK 6.3	1993	Spring	599	10	0	2
EFK 6.3	1994	Spring	234	10	1	1
EFK 6.3	1995	Spring	2474	22	2	7
EFK 6.3	1996	Spring	933	14	0	4
EFK 6.3	1997	Spring	2289	13	0	0
EFK 6.3	1999	Spring	1247	18	2	14
EFK 6.3	1985	Fall	61	7	3	12
EFK 6.3	1986	Fall	38	8	11	20
EFK 6.3	1987	Fall	234	17	23	5
EFK 6.3	1988	Fall	166	17	27	3
EFK 6.3	1989	Fall	100	11	1	1
EFK 6.3	1990	Fall	542	21	25	5
EFK 6.3	1991	Fall	442	18	27	7
EFK 6.3	1992	Fall	244	22	17	2
EFK 6.3	1993	Fall	212	20	13	2
EFK 6.3	1994	Fall	226	21	25	3
EFK 6.3	1995	Fall	216	19	26	1
MIK 1.43	1999	Spring	976	38	32	17
MIK 1.43	2000	Spring	514	36	25	43
MIK 1.43	1998	Fall	148	20	38	7

Table 2. Benthic Data Summary Statistics for the Average Number of Organisms per Sample

Season	Location	Total number of Samples	Mean	Standard deviation	Coefficient of Variation	Maximum	Minimum	Probability for normality
Spring	BCK 0.1	3	277.44	106.30	38.313	400.00	210.333	0.79595
Spring	BCK 3.3	15	465.48	306.66	65.880	1221.33	72.333	0.92088
Spring	DBK 0.3	3	658.67	217.69	33.050	788.00	407.333	0.76444
Spring	EFK 2.3	3	492.67	345.26	70.080	867.33	187.333	0.96976
Spring	EFK 5.1	3	542.89	311.17	57.318	823.67	208.333	0.97760
Spring	EFK 6.3	13	1424.55	1009.23	70.845	3694.20	234.000	0.92712
Spring	MIK 1.43	2	745.00	327.15	43.913	976.33	513.667	1.00000
Fall	BCK 0.1	2	344.67	182.90	53.067	474.00	215.333	1.00000
Fall	BCK 3.3	13	480.34	293.87	61.180	1132.00	95.000	0.94900
Fall	DBK 0.3	2	964.00	1084.70	112.521	1731.00	197.000	1.00000
Fall	EFK 2.3	2	154.33	51.38	33.294	190.67	118.000	1.00000
Fall	EFK 5.1	2	285.33	41.48	14.539	314.67	256.000	1.00000
Fall	EFK 6.3	11	225.64	151.25	67.034	541.80	38.400	0.89008
Fall	MIK 1.43	1	147.67	.	.	147.67	147.667	.

Table 3. Benthic Data Summary Statistics for the Average Number of Taxa per Sample

Season	Location	Total number of Samples	Mean	Standard deviation	Coefficient of Variation	Maximum	Minimum	Probability for normality
Spring	BCK 0.1	3	27.4444	3.2886	11.9827	29.6667	23.6667	0.83219
Spring	BCK 3.3	15	31.3067	7.3822	23.5802	42.0000	14.0000	0.93319
Spring	DBK 0.3	3	29.2222	5.3886	18.4401	35.0000	24.3333	0.97959
Spring	EFK 2.3	3	14.6667	1.8559	12.6540	16.3333	12.6667	0.97581
Spring	EFK 5.1	3	14.6667	4.0961	27.9277	17.6667	10.0000	0.87583
Spring	EFK 6.3	13	13.3692	5.0904	38.0756	23.0000	5.8000	0.93492
Spring	MIK 1.43	2	37.3333	1.4142	3.7881	38.3333	36.3333	1.00000
Fall	BCK 0.1	2	21.1667	2.1213	10.0220	22.6667	19.6667	1.00000
Fall	BCK 3.3	13	29.2872	8.1405	27.7956	41.6667	15.4000	0.93373
Fall	DBK 0.3	2	31.8333	12.9636	40.7234	41.0000	22.6667	1.00000
Fall	EFK 2.3	2	12.6667	1.4142	11.1648	13.6667	11.6667	1.00000
Fall	EFK 5.1	2	20.0000	2.3570	11.7851	21.6667	18.3333	1.00000
Fall	EFK 6.3	11	16.4000	5.1962	31.6839	21.6000	7.2000	0.82890
Fall	MIK 1.43	1	20.3333	.	.	20.3333	20.3333	.

Table 4. Benthic Data Summary Regression Table for the Average Number of Organisms per Sample

Location	Season	Parameter Estimate	Standard Error	Pr > |t|	R-Square	LCL	UCL
BCK 0.1	Spring	-64.40476	26.35192	0.2472	0.8566	-399.24	270.43
BCK 0.1	Fall	-129.33333	.	.	1.0000	.	.
BCK 3.3	Spring	26.95972	14.76491	0.0909	0.2041	-4.9379	58.8574
BCK 3.3	Fall	42.23581	8.87341	0.0006	0.6732	22.7056	61.7661
DBK 0.3	Spring	-109.28571	91.46878	0.4436	0.5881	-1271.51	1052.94
DBK 0.3	Fall	-767.00000	.	.	1.0000	.	.
EFK 2.3	Spring	-35.71429	223.18712	0.8990	0.0250	-2871.58	2800.15
EFK 2.3	Fall	36.33333	.	.	1.0000	.	.
EFK 5.1	Spring	154.90476	132.29569	0.4500	0.5782	-1526.07	1835.88
EFK 5.1	Fall	29.33333	.	.	1.0000	.	.
EFK 6.3	Spring	8.65391	75.45602	0.9108	0.0012	-157.42	174.73
EFK 6.3	Fall	17.76364	14.00078	0.2364	0.1517	-13.9083	49.4356
MIK 1.43	Spring	-462.66667	.	.	1.0000	.	.
MIK 1.43	Fall	0	.	.	.	.	.

Table 5. Benthic Data Summary Regression Table for the Average Number of Taxa per Sample

Location	Season	Parameter Estimate	Standard Error	Pr > |t|	R-Square	LCL	UCL
BCK 0.1	Spring	-0.19048	2.14444	0.9436	0.0078	-27.4382	27.0573
BCK 0.1	Fall	-1.50000	.	.	1.0000	.	.
BCK 3.3	Spring	0.97688	0.29210	0.0053	0.4625	0.3458	1.6079
BCK 3.3	Fall	1.02802	0.29796	0.0054	0.5197	0.3722	1.6838
DBK 0.3	Spring	-2.66667	2.30940	0.4544	0.5714	-32.0104	26.6771
DBK 0.3	Fall	-9.16667	.	.	1.0000	.	.
EFK 2.3	Spring	0.92857	0.78355	0.4462	0.5841	-9.0273	10.8845
EFK 2.3	Fall	1.00000	.	.	1.0000	.	.
EFK 5.1	Spring	2.35714	1.27842	0.3164	0.7727	-13.8867	18.6010
EFK 5.1	Fall	-1.66667	.	.	1.0000	.	.
EFK 6.3	Spring	0.66811	0.32317	0.0631	0.2798	-0.04319	1.3794
EFK 6.3	Fall	1.21273	0.33063	0.0052	0.5992	0.4648	1.9607
MIK 1.43	Spring	-2.00000	.	.	1.0000	.	.
MIK 1.43	Fall	0	.	.	.	.	.

Table 6. Benthic Data Summary Statistics for the Average Percent of Chironomid Organisms

Season	Location	Total number of Samples	Mean	Standard deviation	Coefficient of Variation	Maximum	Minimum	Probability for normality
Spring	BCK 0.1	3	9.0763	3.7879	41.735	13.1537	5.6667	0.97669
Spring	BCK 3.3	15	4.7837	3.9307	82.169	12.9032	0.9639	0.83039
Spring	DBK 0.3	3	2.7718	1.7117	61.752	4.7463	1.7079	0.78774
Spring	EFK 2.3	3	12.2389	0.9767	7.980	13.3452	11.4961	0.89615
Spring	EFK 5.1	3	11.0347	10.5174	95.312	22.9057	2.8800	0.90636
Spring	EFK 6.3	13	4.2764	3.4305	80.219	13.5204	0.4806	0.83776
Spring	MIK 1.43	2	30.0712	17.9510	59.695	42.7644	17.3779	1.00000
Fall	BCK 0.1	2	4.2130	2.8932	68.673	6.2588	2.1672	1.00000
Fall	BCK 3.3	13	6.1514	4.0159	65.285	15.9851	0.8837	0.88337
Fall	DBK 0.3	2	9.7625	1.9870	20.354	11.1675	8.3574	1.00000
Fall	EFK 2.3	2	6.7041	7.0841	105.668	11.7133	1.6949	1.00000
Fall	EFK 5.1	2	2.5490	0.2903	11.387	2.7542	2.3438	1.00000
Fall	EFK 6.3	11	5.3973	5.8209	107.850	20.3125	1.2000	0.72987
Fall	MIK 1.43	1	6.7720	.	.	6.7720	6.7720	.

Table 7. Benthic Data Summary Statistics for the Average Percent of EPT Organisms

Season	Location	Total number of Samples	Mean	Standard deviation	Coefficient of Variation	Maximum	Minimum	Probability for normality
Spring	BCK 0.1	3	22.8689	11.6596	50.984	35.9167	13.4707	0.92652
Spring	BCK 3.3	15	52.7560	12.5501	23.789	72.5904	30.4147	0.95675
Spring	DBK 0.3	3	40.6513	5.0226	12.355	45.9814	36.0065	0.98603
Spring	EFK 2.3	3	1.9443	1.5879	81.671	3.5587	0.3843	0.99912
Spring	EFK 5.1	3	1.0484	0.5691	54.280	1.5783	0.4469	0.98813
Spring	EFK 6.3	13	0.7226	0.8989	124.411	2.7098	0.0054	0.77481
Spring	MIK 1.43	2	28.3198	4.9014	17.307	31.7856	24.8540	1.00000
Fall	BCK 0.1	2	61.4963	10.8877	17.705	69.1950	53.7975	1.00000
Fall	BCK 3.3	13	48.9288	17.0872	34.922	70.9364	24.0497	0.91957
Fall	DBK 0.3	2	16.7042	0.0666	0.399	16.7513	16.6570	1.00000
Fall	EFK 2.3	2	11.9444	9.4747	79.324	18.6441	5.2448	1.00000
Fall	EFK 5.1	2	35.2644	9.4225	26.720	41.9271	28.6017	1.00000
Fall	EFK 6.3	11	17.9908	9.6111	53.422	26.8778	1.0000	0.84680
Fall	MIK 1.43	1	38.1490	.	.	38.1490	38.1490	.

Table 8. Benthic Data Summary Regression Table for the Average Percent of Chironomid Organisms

Location	Season	Parameter Estimate	Standard Error	Pr > |t|	R-Square	LCL	UCL
BCK 0.1	Spring	-6.37398	4.19936	0.3709	0.6973	-59.7320	46.9840
BCK 0.1	Fall	7.69879	.	.	1.0000	.	.
BCK 3.3	Spring	0.12716	0.67640	0.8538	0.0027	-1.3341	1.5884
BCK 3.3	Fall	0.70347	0.87719	0.4396	0.0552	-1.2272	2.6342
DBK 0.3	Spring	-3.27964	0.23544	0.0456	0.9949	-6.2712	-0.2881
DBK 0.3	Fall	0.04712	.	.	1.0000	.	.
EFK 2.3	Spring	0.36931	0.97171	0.7688	0.1262	-11.9774	12.7161
EFK 2.3	Fall	-6.69966	.	.	1.0000	.	.
EFK 5.1	Spring	-0.15957	0.33665	0.7182	0.1835	-4.4371	4.1179
EFK 5.1	Fall	-6.66269	.	.	1.0000	.	.
EFK 6.3	Spring	0.09007	0.06152	0.1712	0.1631	-0.04534	0.2255
EFK 6.3	Fall	1.34546	0.85552	0.1502	0.2156	-0.5899	3.2808
MIK 1.43	Spring	-6.93160	.	.	1.0000	.	.
MIK 1.43	Fall	0	.	.	.	.	.

Table 9. Benthic Data Summary Statistics for the Average Percent of EPT Organisms

Location	Season	Parameter Estimate	Standard Error	Pr > |t|	R-Square	LCL	UCL
BCK 0.1	Spring	1.31814	2.10044	0.6432	0.2826	-25.3705	28.0068
BCK 0.1	Fall	-2.04580	.	.	1.0000	.	.
BCK 3.3	Spring	-0.38333	0.18358	0.0570	0.2512	-0.7799	0.01327
BCK 3.3	Fall	0.38223	0.17806	0.0550	0.2952	-0.00969	0.7741
DBK 0.3	Spring	0.81335	0.77077	0.4829	0.5269	-8.9802	10.6069
DBK 0.3	Fall	1.40505	.	.	1.0000	.	.
EFK 2.3	Spring	0.55542	0.31672	0.3299	0.7546	-3.4689	4.5797
EFK 2.3	Fall	5.00919	.	.	1.0000	.	.
EFK 5.1	Spring	2.69853	6.33439	0.7436	0.1536	-77.7875	83.1846
EFK 5.1	Fall	0.20524	.	.	1.0000	.	.
EFK 6.3	Spring	0.35784	0.23285	0.1526	0.1767	-0.1547	0.8704
EFK 6.3	Fall	-1.14784	0.44256	0.0290	0.4277	-2.1490	-0.1467
MIK 1.43	Spring	25.38649	.	.	1.0000	.	.
MIK 1.43	Fall	0	.	.	.	.	.